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Critical Thinking Training for Army Officers
Volume One: Overview of Research Program

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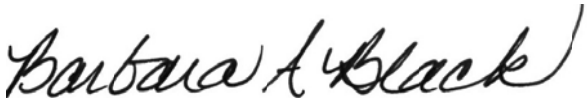

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14. ABSTRACT *(Maximum 200 words)*: This report is the first of three volumes describing a multi-year research program to develop and validate web based training in critical thinking for Army officers. This first volume presents an overview of the research efforts that developed and validated a theoretical model for the training, selected and validated eight high impact critical thinking skills for Army officers, and developed and evaluated the training course. The report documents the systematic approach that was used to develop a computer based, on-line, training program designed to promote CT in Army officers. Volume two of this series presents, in more detail, the model and theoretical basis for the training and the experiments that were conducted to validate the model. Volume three describes a prototype training system for two critical thinking skills, including the functional requirements, pedagogical principles, course content, and evaluation of the training. A fourth report describes an expanded version of the system that was developed to train eight critical thinking skills.

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Research Report 1881

CRITICAL THINKING TRAINING FOR ARMY OFFICERS VOLUME ONE: OVERVIEW OF RESEARCH PROGRAM

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Because this volume provides an overview of our work on critical thinking, we would like to acknowledge those individuals who made this program of research possible. First, we would like to thank several research psychologists at Army Research Institute (ARI), Dr. Jon Fallesen (now at the Center for Army Leadership), Dr. Michelle Zbylut, and Mr. Robert Solick, for the many hours of meetings in which they generously offered their experience and knowledge for the improvement of our research. Finally, we would like to thank Dr. Stanley Halpin, Chief of the ARI Fort Leavenworth Research Unit, for his on-going support of this work.

CRITICAL THINKING TRAINING FOR ARMY OFFICERS VOLUME ONE: OVERVIEW OF THE RESEARCH PROGRAM

EXECUTIVE SUMMARY

Research Requirement:

Advanced training in critical thinking (CT) is needed for adult populations in many fields of work. Not surprisingly, the United States military is at the forefront of efforts to promote and improve thinking skills. Military leadership demands the application of high quality CT for effective battle command. However, a theory based, comprehensive, and widely available program of training is needed. Moreover, the scientific literature on critical thinking is highly fragmented and no dominant or consensus model of the construct has been developed. To address the issues surrounding the concept of CT and its development, the research summarized in this report focused on two central objectives. The first objective was to develop a predictive model of CT that enhanced our understanding of the construct and could be used to guide future research. The second objective of the research was to develop a distance-based training system, designed to improve the CT skills of Army officers.

This report is the first in a series of three volumes that describe a multi-year research program to develop and assess a web-based system for training critical thinking for Army officers. This volume gives a general overview of the research program. The second volume (Fischer, Spiker, & Riedel, 2008a) describes in more detail the development and validation of a model of critical thinking and the selection of critical thinking skills to train. The third volume (Fischer, Spiker, & Riedel, 2008b) documents lessons learned in teaching critical thinking appearing in the literature and lessons learned by Army instructors and curriculum developers of critical thinking training**.** It also describes the requirements and course curriculum for the prototype training system.

Procedure:

A predictive model of CT was developed and two research projects were conducted to validate the model. The first project was an experimental test of a number of the hypotheses of the model. The second validation project examined whether the model could be applied to Army battle command and identified eight CT skills that are both important and problematic to Army battle command. The model and the eight skills were then used to guide development of the training curriculum. A web-based, prototype training program was then developed that targeted development of two of the eight CT skills.

To develop the training curriculum, teaching methods first were identified that were likely to be most effective at developing CT in Army officers. Two investigative strategies were adopted to determine the best methods. First, lessons learned from the research literature on training CT and distance-based learning were identified. Second, Army instructors and instructional developers who were involved in teaching CT were surveyed to identify their

successes and the problems they currently face. The results from the two research strategies were then used to establish functional requirements for web-based CT instructional material.

A web-based instructional system targeting CT, *Computerized Training in Critical Thinking* or $(CT)^2$, was then developed using the functional requirements to guide its design. A set of pedagogical principles derived from the literature review, survey results, functional requirements, and practical considerations served as the basis of the $(CT)^2$ design.

To evaluate the effectiveness, usability, and student acceptance of $(CT)^2$, an empirical investigation was conducted in which participants from the 85th Reserve Training Division worked through parts of the training. The central objective of the evaluation was to determine whether the CT training system effectively increased measurable indicators of CT compared to two other training conditions. The research also assessed participating students' attitudes and subjective evaluations of $(CT)^2$ as indicators of acceptance and usability.

Findings:

The model that was developed incorporates many ideas about CT offered by leading thinkers in philosophy and education. It includes many of the CT skills and predisposing attitudes discussed in the CT literature. It also specifies the relationships among a variety of variables that previous researchers have discussed, such as the influence of experience and knowledge, and the relationship of CT to cognitive tasks (e.g., judgment and problem solving). The model, however, goes beyond the largely rational/analytic work conducted to date by providing a framework in which CT can be empirically investigated as a cognitive process.

The validation research tested several predictions of the model. Many of the findings supported the premises of the model, but some indicated the need for greater detail of specific model elements. The results of the second validation effort, which tested whether the model could be applied to Army battle command, indicated that the CT model largely captures the skills, situational conditions, and predisposing factors significant to Army battle command. The results of this research were used to identify a set of eight CT skills which are important and problematic to Army battle command.

Based, in part, on the model of CT that was developed, an examination of the literature on training critical thinking and on a survey of Army instructors and curriculum developers, requirements were developed for the training system. The focus of $(CT)^2$ is to improve key critical thinking skills that support Army battle command. CT involves a deliberate, systematic awareness of the process and products of one's own thinking. The training program targets awareness of one's own thinking and common errors that people make when they fail to apply appropriate CT skills. These errors include overlooking important details, misinterpreting information, and making incorrect assumptions – all of which can lead to poor decision-making. The training program highlights awareness of these errors and teaches specific techniques that can help people overcome them. It presents the student with real-world situations and asks them to complete numerous thinking exercises that require the practice and application of CT skills in a variety of realistic settings.

The results of the evaluation with the 85th Reserve Training Division indicated that military students find $(CT)^2$ very acceptable; however, the findings are based on a relatively small sample. The material was uniformly positively rated. Despite the extensive time commitment the training program requires, users found the training interesting and well worth their time. $(CT)^2$ also appears to be generally effective at encouraging critical thinking with regard to messages Army personnel must evaluate. The research showed that the web-based training enhanced memory for messages, possibly because it encourages greater depth of processing. $(CT)^2$ also seems to inhibit the production of (potentially incorrect) inferences that go well beyond what is explicitly given in the message. Participants who took the $(CT)^2$ training made significantly fewer unjustified inferences than participants assigned to the other two training conditions. Examination of the responses reveals that $(CT)^2$ participants did make inferences; however, they justified them by pointing out explicit information given in the message that supported their inferences. Therefore, $(CT)^2$ appears to encourage discrimination of what is "known" or "given" from what might be added (i.e., inferred) by the perceiver.

Utilization and Dissemination of Findings:

The model of CT generated a number of predictions about critical thinking that had not been previously empirically tested. The model was sufficiently specified to permit falsification of many of its assertions. As a result, current knowledge of CT has been significantly extended. Although the results of the validation research were mixed in their support of the model, it is clear that the model has passed an important scientific criterion in that it has generated testable hypotheses that have produced empirical findings.

The results of this research program also have practical implications for the design of information systems and for educational purposes that seek to improve the application of CT skills. The CT skills identified in this research as important and problematic to Army battle command may be utilized for training and assessment purposes and to increase Soldiers' self-awareness of their thinking. Training concepts derived in this research and discussed in Fischer, et al. (2008b) have also been adopted at the Army Command and General Staff College to teach the key CT skills identified by the present research.

This report provides an overview of an extended program of research dealing with the training of CT for Army officers. It describes the systematic approach that was used to develop a computer based, on-line educational program designed to promote the CT of Army officers and provides documentation of an empirical evaluation of the $(CT)^2$. Researchers, teachers, and curriculum developers can use this report as a stepping-stone to the development of future CT educational programs, or to better understand $(CT)^2$ for their own use.

CRITICAL THINKING TRAINING FOR ARMY OFFICERS VOLUME ONE: OVERVIEW OF RESEARCH PROGRAM

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VOLUME ONE: OVERVIEW OF RESEARCH PROGRAM

INTRODUCTION

Background

Interest in promoting critical thinking (CT) skills has increased over the past 20 years in a variety of diverse settings such as public education, military leadership, nursing, technical vocations, and corporate business (e.g. Onwuegbuzie, Schwartz, & Rice, 2000). CT has also become a recognized construct in philosophy, education, and, to a lesser degree, psychology.

Not surprisingly, the United States military is at the forefront of the effort to promote and improve thinking skills such as critical thinking skills. Military decision-making demands the application of high quality CT for effective battle command, where battle command applies "to the leadership element of combat power...Commanders visualize the operation, describe it in terms of intent and guidance, and direct the actions of subordinates within their intent. They directly influence operations by personal presence…" (Department of the Army, 2001, Section 5-1). Army leaders often find themselves in situations that bear little resemblance to conflict situations they have previously experienced or studied. In recent years, they have been expected to serve peacekeeping roles, for example, in which their job is to control conflict among two or more opposing and hostile groups within a foreign country. In such situations, learned rules of engagement and historical principles of warfare often do not apply. There is no single enemy and battle lines may not exist. In such situations, novel solutions that are the product of CT are likely to be critical to success. Hence, Soldiers cannot simply base their battle plans on well-learned battlefield patterns; they must reason through and integrate an enormous amount of information. Lessons learned from Operation Iraqi Freedom, for example, are accumulated and distilled into new doctrine (e.g., the new counterinsurgency field manual, FM 3-24). That doctrine is incorporated into training and education, but the problem persists. It is not possible to anticipate all possible situations which will arise, and the leaders will need to draw on their thinking skills to understand and develop responses in unfamiliar situations.

Extensive training time is devoted to the teaching of content knowledge in the military. Many hours are spent examining and evaluating historical battles to develop a deep understanding of the relationships among the principal factors affecting the outcomes of warfare. In contrast, relatively little training time has been spent on improving the *process* of thinking and decision-making. It is not that the Army educational system has neglected to provide instruction in CT or reasoning. However, fewer resources have been devoted to the training of thinking processes than to other important skills (Riedel, Morath, & McGonigle, 2001). Moreover, the prescriptive and procedural nature of the doctrinal methods may actually discourage the application or development of thinking skills, inhibiting the creation of novel solutions that might be the result of CT (Fallesen, Michel, Lussier, & Pounds, 1996). In short, the education of military commanders seems to be a prime opportunity for training designed to foster thinking skills, and that the domain of battle command is one in which CT is crucial.

The Research Program

The central purpose of the research program documented in this report was to develop training in critical thinking for Army personnel. This report describes the systematic approach that was used to develop a computer based, on-line educational program designed to promote CT in Army officers. Two companion volumes describe the research program in more detail. This volume presents a summary of the series of research efforts that culminated with the development and evaluation of the CT training for Army personnel. First, a theoretical model of critical thinking was developed and validated. This model subsequently guided development of the training system. Then the role of CT in Army battle command was investigated. Research was conducted to determine the degree to which the CT model was applicable to the kinds of problems faced by Army leaders. The research demonstrated that a number of CT skills are both important and problematic to battle command. Eight CT skills, in particular, were identified as high impact skills for battle command and selected as the target skills for the web based training. Next, lessons learned from past research and from a survey of Army instructors and instructional designers were analyzed to help define the requirements for the CT training system, Computerized Training in Critical Thinking $(CT)^2$. Finally, $(CT)^2$ was designed implemented, and evaluated.

Volume Two of this series presents, in more detail, the model and theoretical basis for the prototype training system that was developed for two of the eight skills and the experiments that were conducted to validate the model. Volume Three describes the training that was developed, including the functional requirements, pedagogical principles, course content, and evaluation of the training. A fourth report describes an expanded training system that was developed to train all eight critical thinking skills (Fischer, Spiker, Harris, McPeters, & Riedel, 2008).

A Model of CT

Development of training that effectively and efficiently improve critical thinking skills important for proficient battle command starts with the identification of the skills required. An empirically grounded model is essential to any effort seeking a meaningful improvement in CT skills because it would serve to identify those skills. In addition, before effective training can be developed, training objectives must be specified, and those objectives should be derived from an empirically tested model of CT. However, no such model existed prior to this research.

A model of CT was needed that was sufficiently specific so that it could be subjected to empirical testing. The model could then be used to organize and test many of the hypotheses appearing in the literature. Such a model would also point to future areas of research.

The model developed in the course of this research program (see Figure 1) is based on a review of the literature on critical thinking (Fischer, et al., 2008b) and incorporates many ideas about CT offered by leading thinkers in philosophy and education. It embodies many of the CT skills and predisposing attitudes discussed in the CT literature. It also specifies the relationships among a variety of variables that previous researchers have discussed, such as the influence of experience and knowledge, and the relationship of CT to cognitive tasks (e.g., judgment and

problem solving). However, the model goes beyond the largely rational/analytic work conducted to date by providing a framework in which CT can be empirically investigated as a cognitive process.

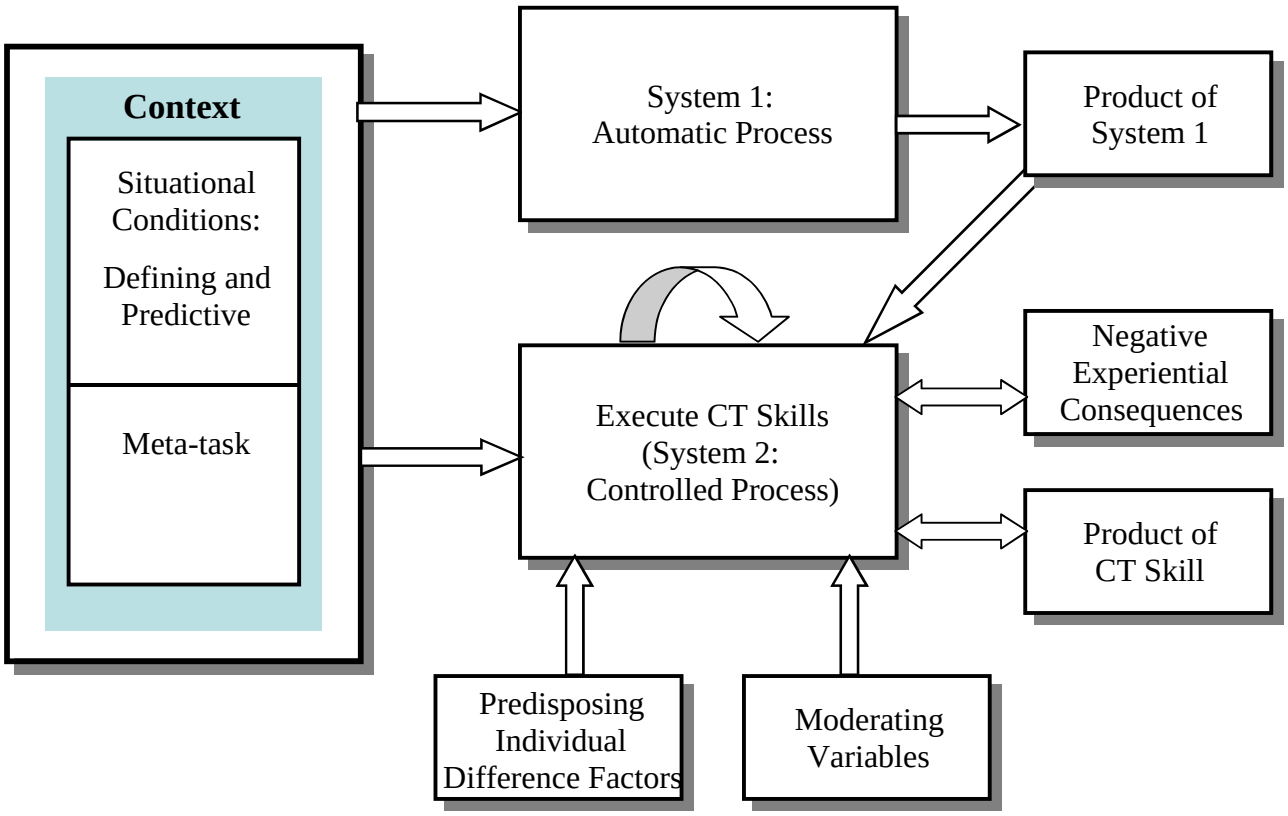

Figure 1. Process model of critical thinking.

Generally stated, the model posits that CT is a cognitive process that intervenes between a set of initiating situational conditions and the observable performance of one or more tasks. It is purposeful and deliberate cognitive processing that includes checks on the process and products of thinking and serves other higher-level tasks such as decision-making. CT involves the application of least one of a particular set of cognitive skills that demand the use of meta-cognitive and/or recursive control, consciously controlled logic, or thorough examination of a problem. The execution of CT skills is powered by an effortful, yet flexible, computational process that is capable of controlled meta-cognitive and recursive monitoring of thinking. The processing engine is distinguished from the quick, yet powerful, recognition-based processing (Klein, 1999) that depends on association strengths and that is subject to well-documented accessibility errors (Kahneman, 2003). The application of CT skills has accompanying affective consequences, which may be measured using standard physiological preparations or psychometric instruments.

The model places CT in the context of cognitive processes posited by the most current models of reasoning and judgment (Kahneman, 2003). The model incorporates six major factors involved in CT including, (1) situational conditions, (2) meta-tasks, (3) CT skills, (4) predisposing individual differences, (5) moderating variables, and (6) negative experiential consequences. Figure 1 shows the components of the model. Volume Two of this series gives a more detailed description of the model and the literature review that informed its development.

CT is considered in this model to occur within a relatively brief time frame (in the range of 5 to 30 minutes) in which certain essential processing functions are executed, depending on the desired goal. One can, however, string together a series of CT episodes, held together via meta-cognitive monitoring processes, which would define a much longer CT period that might encompass a training exercise, a class, or some important real-world event (e.g., an entire intelligence briefing). If a given individual shows a tendency to initiate CT skills on a frequent basis, he or she might be labeled as a "critical thinker." For a variety of reasons, individuals may vary in the quality of their critical thinking, and the quality of the measurable products of the application of CT skills. In this model, critical thinking skills are considered both measurable and modifiable via experience. Therefore, it should be possible to develop and evaluate a robust training program to promote CT skills. Furthermore, if one can identify particular skills or classes of skills that are more commonly associated with high-performance outcomes, then a major effort to train those skills should yield high-payoffs for participating organizations.

In summary, our working definition of CT is: *Critical thinking is a time-limited mode of controlled, deliberate, processing that is purposeful, stimulus-driven, and context-bound. Integral to CT are checks on the process and products of thinking, which make it a fundamentally meta-cognitive process. Its function is to serve other cognitive tasks such as decision-making and problem solving.*

EXPERIMENTAL VALIDATION OF THE CT MODEL

This section gives an overview of the method and results of an experiment that examined several predictions of the model. A detailed description of the experiment is contained in Volume Two of this series.

Predictions of the Model

An experiment was conducted to examine the validity of several of the model's predictions. The first set of predictions investigated by the experiment dealt with the role of substantive information in critical thinking. The model posits that the situation must include substantive information, which is the material to which the CT skills are applied. The model also asserts that substantive information will increase the tendency to employ CT skills compared to less substantive information. The model further states that the use of CT skills is more likely if the information presented by the situation is conflicting, disordered, uncertain, complex or requires extensive logical reasoning. To test these predictions, the amount of content in the stimulus material, as defined by the number of unique propositions, was varied. Additionally, one condition was examined in which inconsistent (i.e., contradictory) information was incorporated into the stimulus material.

A second prediction that was tested concerned the purposeful nature of CT. Specifically, the model states that one engages in CT skills only when the situational context requires at least one of four meta-tasks, i.e., when one's task is to understand some material, solve a problem, make a decision, or make an evaluative judgment. To test this hypothesis, participants were asked to perform three tasks (judgment, understanding, and identification of the general topic) on stimulus material that varied in substance.

A third prediction tested by the experiment involved the effect of predisposing individual difference factors on the application of CT skills. The model states that differences exist among individuals in their tendency to use CT. To evaluate the influence of predisposing factors, participants were asked to complete an assessment instrument, the Need for Cognition Scale (NFC) (Cacioppo, Petty, & Kao, 1984), which was used as a measure of the tendency to engage in thought.

A fourth prediction of the model tested in the experiment involved the effects of moderating variables on CT. Specifically, the model predicts that expertise should affect the quality of CT, i.e., how well someone executes a CT skill. However, it should not affect whether one attempts to perform that CT skill. To test this prediction, two groups of participants were recruited who varied in amount of training in psychological research, namely undergraduate and graduate students in psychology. Here, amount of training was used as an operational measure of expertise.

Finally, the experiment tested the model prediction that CT elicits negative affect because it requires effort. The model predicts that the application of CT skills should be associated with a corresponding increase in negative affect and in effort. This prediction was tested by measuring affect and effort immediately following each trial of the experiment.

Method

Twenty-six participants (5 males and 21 females), ranging in age from 20 to 51 years of age, took part in the experiment. All participants had taken at least one course in experimental psychology. Eleven were undergraduate students and 15 were graduate students. All participants received a test booklet containing nine problems. Each problem presented the participants with a specific task to apply to a short paragraph that described a research experiment in the area of experimental psychology. Over the nine problems, participants were asked to perform three different tasks. The task instructions asked participants to either 1) understand, 2) make a judgment about, or 3) simply identify the general topic of the material presented. The substantive content of the paragraphs describing the nine research studies was also varied. Three different types of substantive content were presented. The first type contained very little substantive information, as measured by number of propositions presented. The second type was more substantive than the first, i.e., presented a greater number of propositions. The third type was as substantive as the second, but also included several propositions that were inconsistent, i.e., contradictory, with one another.

Participant measures included the Need for Cognition (NFC) scale, self-reported mental effort and affect ratings for each condition, response time for each trial, and indicators of the application of CT skills derived from the verbal protocols. Each of these measures is relevant to one or more hypotheses generated by the CT model.

Results of the Validation Experiment

The statistical analyses for this experiment are reported in Volume Two of this series. This section reports a summary of those findings.

Effects of Substance of Material on CT

As previously discussed, the model asserts that substantive information will increase the tendency to employ CT skills compared to less substantive information. A second prediction concerning the substance of stimulus material is that the use of CT skills is more likely if the information presented is conflicting, disordered, uncertain, and complex or requires extensive logical reasoning. Examining all four measures, the results of the statistical analyses do not support the prediction that high substance material increases the tendency to apply CT skills. Under some task conditions, low substance material can actually generate more CT than high substance material. Specifically, when asked to make a judgment about low substance material, more questions of belief were asked than when asked to make a judgment about high substance material.

The results, however, do support the prediction that the application of CT skills is more likely if the available information is degraded in some way, i.e., is conflicting, disordered, uncertain, etc. A general pattern emerges that inconsistent material tends to take longer to process and produces more questions of belief and checks on thinking.

These results have practical implications for the design of information systems as well as for training purposes that seek to increase the tendency to apply CT skills. Designers should be

aware that people may not question or check highly substantive material any more than low substantive material. If CT is desired, inconsistent content might be highlighted by information systems. Similarly, if training systems seek to encourage CT, one strategy would be to sensitize students to inconsistent material.

Effects of Task on CT

According to the model, CT skills should only be engaged when the situational context includes at least one of the four CT meta-tasks. The response time and effort ratings supported the predictions concerning task requirements. The prediction was also supported in that both the judgment and understanding tasks generated more questions of belief than did the identification task. However, the understanding task failed to generate more checks on thinking than the identification task. Therefore, the prediction that understanding is a meta-task that elicits CT was not supported by the checks on thinking data. Moreover, it appears that understanding and judgment may not elicit CT equally. These results suggest that refinement of the model may be needed with regard to task. While the results generally support the idea that understanding and judgment encourage the application of CT skills, the results also suggest that judgment thus can be more effective at doing so.

Effects of Predisposing Factors on CT

The model states that differences exist among individuals in their tendency to use CT. One would expect a positive relationship between independent measures of predisposition and indicators that CT has been used. The results of this experiment failed to support the notion that predisposing individual difference factors affect the tendency to engage in CT skills. None of the correlations of the NFC scale with the response measures—response time, effort, affect, questions of belief, or checks on thinking – achieved statistical significance. While surprising, this negative result may be the consequence of a homogeneous subject population—college students—with a high overall tendency to engage in CT. Or the NFC may not be a good measure of tendency to use CT.

Effects of Moderating Variables on CT

According to the model, expertise and experience should affect the quality of CT but not the likelihood that one will engage in CT. The model's prediction concerning experience was supported in the response time and effort data. No differences were observed between graduates and undergraduates in these two measures, nor was there any difference in reported affect between the two groups of participants. However, the more decisive indicators of CT (i.e., measures of questions of belief and checks on thinking) did support the prediction. Graduate students asked more questions and checked their thinking more than undergraduates, which suggests they applied their CT skills more. Therefore, it appears that experience does affect the application of CT skills. However, this conclusion is weakened by the possibility that, on average, graduate students are more intelligent than undergraduates and intelligence is related to the likelihood that one will engage in CT.

Effects of CT on Negative Affect

According to the model, the application of CT skills should be associated with a corresponding increase in negative affect. Those conditions hypothesized to elicit CT such as the tasks of understanding and judgment and high substance and inconsistent material should be rated as less enjoyable than the other conditions of the experiment. The findings of the present experiment were mixed in their support of this hypothesis. Participants reported that they enjoyed processing inconsistent summaries less than the other summaries, which is congruent with the model's prediction. However, the equivalent ratings for the low and high substance material failed to support the prediction. In summary, negative affect was not directly related to CT in this experiment. Instead, it appears in this case that other factors determined the level of enjoyment experienced by participants.

Conclusions of Model Validation Experiment

The model of CT generated a number of predictions that had not been previously empirically tested. The model was sufficiently specified to permit falsification of many of its predictions, a capability which analytic accounts of CT had not provided. As a result, a clearer picture of the effects of task and stimulus substance on CT has emerged.

Although the results of the validation experiment were mixed in their support of the model, it is clear that the model has passed an important scientific criterion: it has generated testable hypotheses that have produced empirical findings. This research provides one test of the model's predictions; there are many more hypotheses to be tested and the findings of the present research should be examined further, replicated, and extended. Some of the findings point to places in the model that require greater specification or modification. Other findings are consistent with the model's predictions. Future research is needed to further develop the model and to increase our understanding of CT.

VALIDATION OF THE CT MODEL AS APPLIED TO ARMY BATTLE COMMAND

The results of the experimental validation of the CT model supported some of the model's predictions. However, confirmation of predicted relationships generated by a model is only one aspect of its validation. The degree to which any psychological model can be applied to real-world situations is also an important measure of its validity. Thus, a second investigation was conducted to determine whether the model of CT was applicable to the domain of Army battle command. The domain of Army battle command was chosen because it demands high levels of CT ability for reasons previously discussed. This investigation is described in more detail in Fischer, et al, (2008a).

Method

The purpose of the investigation was to determine whether the model adequately defined CT skills (CTS), situational conditions, and predisposing factors important and/or problematic to Army battle command. Eighteen Army officers stationed at a large Army installation participated in the research in April, 2000. Participants completed a survey that assessed their opinions and

experiences concerning CTS, predisposing attitudes and situational conditions as applied to the domain of battle command. The survey also prepared participants for guided interviews that further elaborated the answers they had provided on the survey. The session, which lasted between 1.5 and 2 hours, concluded with individual focused interviews on a wide range of topics pertinent to CT in battle command.

The investigation also identified a set of CTS that are both important for battle command and whose execution is problematic or difficult. Thirteen broad classes of CTS had been identified from the literature. These skills were then narrowed down by jointly considering two criteria based on the survey data, namely importance and difficulty. First, participants rated the importance for battle command of the each of the 13 classes of skills. Second, the number of officers who reported that they had observed problems in executing each of the 13 classes of skills was tabulated. In this way a set of eight CTS were identified that participants ranked as both problematic and important to battle command (see Table 1)..

Table 1. Critical Thinking Skills (CTS) - Important and Problematic in Battle Command

CTS #	CTS Title	CTS Definition	Primary Battle Command Task	Battle Command Errors and Deficiencies
1	Frame The Message	Ability to identify essential elements of messages, understand their relationships, and describe high fidelity representation of the message.	Clarify intent of the commanders 1 and 2 levels up	Difficulty in establishing clear and accurate understanding of CDR intent Difficulty in conveying clear CDR intent
2	Recognize Gist In Material	Ability to sort through details in a message (written, graphical, visual, auditory, and/or tabular) and extract the gist therein.	Restate mission objectives provided by upper echelon to write own mission statement	Too much detail in OPORDs that must be filtered to establish gist that supports writing of own mission statement Too little time at lower echelons to accurately extract essence of mission
3	Develop An Explanation That Ties Information Elements Together In A Plausible Way	Ability to: • Arrange evidence logically • Highlight gaps in knowledge. • Develop an explanation or multiple explanations based on evidence • Evaluate explanation(s) for plausibility	Interpret reports of recent enemy activities in area of interest to estimate enemy intent and predict enemy actions	Overlook seemingly unrelated facts Fail to assess the quality of information Difficulty in filtering excessive information Tendency to embellish enemy activity reports—over-reports of enemy contact and movement Tendency to discount initial reports
4	Generalize From Specific Instances to Broader Classes	The ability to recognize and then classify specific facts/incidents/events as part of a general category.	Interpret reports of enemy disposition	Fail to accurately induce patterns of overall movement based on report instances Tendency to disregard reports that do not match expectations Tendency to inflate information in reports

Table 1 (Continued). Critical Thinking Skills (CTS) Important and Problematic in Battle Command.

CTS #	CTS Title	CTS Definition	Primary Battle Command Task	Battle Command Errors and Deficiencies
5	Use Mental Imagery To Evaluate Plans	The ability to accurately create mental images in one's mind how resources will be applied and events will unfold within a situation.	Develop scheme of maneuver War game courses of action (COA)	Failure to visualize events Fail to include sufficient detail in Courses of Action (COAs) Failure to consider contingencies Fail to consider how plans could go wrong Generate only one COA Failure to consider combat multipliers Difficulty in keeping track of mobile forces
6	Challenge One's Bias	Ability to consistently reevaluate one's current view of situations for prejudice or bias as new information is received.	Change own-unit plans based on new tactical input	Tendency to "fight the plan" General reluctance to change plans
7	Examine Other Peoples' Perspectives	Ability to view and interpret circumstances from perspectives of different individuals, cultures, religions, and timeframes.	Interpret reports of recent enemy activities in area of interest	Failure to accurately estimate enemy intent
8	Decide when to seek information based on its value and cost	Ability to evaluate need for new information in terms of its cost in time, resources and risk	Assess current situation	Tendency to spend too much time planning and gathering information Tendency to make quick decisions without gathering more information

Results

The results of this research indicate that the CT model largely captures the skills, situational conditions, and predisposing factors significant to Army battle command. All of the instances of these three model components were regarded as, at least, sometimes important to battle command. However, some components were less important than others, according to our respondents. Application of the criteria of importance and being problematic in battle command resulted in the identification of eight high-payoff CTS (see Table 1).

INTEGRATING THE CT MODEL AND SKILLS INTO THE ARMY CURRICULUM

During the early stages of this project, the Army began a transformation of education and training at all levels; that transformation continues today. One example of this transformation has been ongoing at the Command and General Staff College (CGSC) at Ft Leavenworth, Kansas.

CGSC transformation goals included new curriculum and new methods of instruction to make the instruction more portable and modularized to meet the special needs of officers in different specialties. One strong influence on the process was a policy change whereby 100% rather than 50% of a given year-group of Army officers would be eligible for attendance at CGSC or equivalent instruction. This new system of education is referred to as Intermediate Level Education (ILE).

In 2001 the research program reported in this report was still in its early stages. However, at that time the preliminary CT model had been developed, the CT skills important for Army officers to develop had been identified, and methods that teachers could use to develop those CT skills in their students had been formulated. In a collaboration between ARI and the ILE curriculum development team, the CT model, identified CT skills, and instructional methods from this research program were incorporated into the new ILE curriculum. The original skills identified in the first phase of the present research were incorporated into each of the 5 major blocks of instruction in the Common Core course, i.e. Foundations, Leadership, Strategic Studies, Operational Studies, and Tactical Studies. Within each block is a series of smaller modules. The CT skills were integrated into 16 modules in the form of lessons plans and/or assessment. Each module is divided into a set of lesson plans. The pilot Common Core course incorporated the skills into 63 lesson plans. Also, training concepts discussed in Fischer, et al. (2008b) were adopted to teach the skills.

LESSONS LEARNED IN TRAINING CRITICAL THINKING

The primary goal for $(CT)^2$ was to provide effective training to develop high levels of CT skills. A secondary goal for $(CT)^2$ was to provide a stand-alone system that Army officers could access anywhere in the world. In summary, this research sought to create an easily accessed, state-of-the-art distance-learning instruction that would effectively develop CT ability required to perform important tasks for battle command. To meet this objective, it was important to employ the best-known techniques for promoting CT and distance-based training.

Two investigative strategies were adopted to determine the best methods. First, lessons learned from the research literature on training CT and distance-based learning were examined. The education and psychology literatures were reviewed to determine the types of CT skills for which training has been developed, the methods used to teach CT, and the methods that have been shown to be most effective. Second, current programs to teach CT to Army officers were reviewed. Army instructors and instructional developers who are involved in teaching CT were surveyed to identify successes and problems they have encountered.

The results from the two research strategies were then used to establish the functional requirements for Web-based CT instructional material.

Lessons Learned from Past Research

A literature review of critical thinking training was conducted using sources from education and psychology. The review addressed questions such as: What methods have been used and evaluated for teaching CT? What kinds of CT skills have educators and researchers

targeted? Which methods are most effective for promoting CT? How can the best teaching methods be implemented in a distance learning application? The conclusions of the literature review are summarized below and a detailed treatment of the review is contained in Volume Three of this series (Fischer, et al., 2008b).

The research reviews suggest that CT can be taught in the classroom or as part of a distance-learning program. Distance learning has been effectively used to promote learning of complex cognitive skills. Some studies show that it is superior to other forms of training. This suggests that it might be used to improve CT in adult and juvenile populations. However, distance learning does produce lower motivational levels among students who use it (Edlred, 1994). Therefore, any attempt to teach CT using distance-learning methods should provide motivational components to counteract the isolation inherent in distance learning. Multimedia and interactivity should also be used to increase motivation and to increase the efficiency by which information is transmitted to the student. If an adequate level of interactivity can be provided, as determined by the instructional goals of the training, Web-based training (WBT) should be used to teach CT. WBT facilitates the use of e-mail, which can provide the student with a social network needed to maintain interest and combat isolation. WBT is also easy to modify and distribute in a timely fashion.

Recent instructional theories indicate that CT training should include rich and varied examples, presented in real world contexts. If the training program is computer-based, it should be highly interactive and multimedia. Instruction should be context-rich, problem-based, and goal-oriented and should include interactive simulations for demonstration, exploration, and discovery, and collaborative environments for practice and transfer of knowledge to new situations (Mayer, 1997).

The CT tasks targeted by the training should be selected from the environment to which they will be applied. Therefore, training should target those cognitive tasks that are important and problematic to the Army.

Lessons Learned from Army Instructors and Instructional Developers

The Army currently incorporates formal CT training in their schoolhouse curriculum. Although neither as systematic nor universal, CT education also occurs in field units through experiences and mentoring (Riedel, et al., 2001). Examination of current methods of teaching CT is important in order to capitalize on lessons learned. A survey, described below, was conducted to assess instructors' experiences in the teaching of CT.

Method

Eight instructors and instructional developers participated in the survey. Respondents were Army officers or civilian researchers working at CGSC, Kansas State University, and the Army War College. The CGSC instructors taught at the School for Command Preparation (SCP), the Command General Staff Officers Course (CGSOC), and the Combined Arms Services Staff School (CAS^3). The respondent from Kansas State University was a Professor of Military Science.

Respondents completed a three-section survey that assessed demographic information and their work experience teaching or developing curricula for CT, the classes they taught that involved CT, and their opinions and experiences in teaching CT. When they had completed the survey, they returned their written responses and contacted the researchers.

Results and Conclusions

The results of the survey showed that instructors and curriculum developers were mostly satisfied with how CT was taught at Army educational institutions at that time. They believed that it was adequately covered and that the guiding conception of CT that they used (based on Paul and Elder, 2001) was useful and sufficient. Their experience suggested that realistic, practical exercises that require practicing CT skills are the best way to improve those skills. However, they also recognized that feedback about students' performance is a necessary feature of practical exercises. They also favored rich and varied examples and realistic context for the exercises. Their central complaints as teachers and curriculum developers were that the Army culture tends to (1) create suspicion about the type of slow deliberate thought that characterizes CT, and (2) discourage innovative thinking. For this reason, some instructors and curriculum developers avoided talking about CT in the abstract. They avoided, for example, instruction that refers to various models of CT, and even avoided the term, CT. Instead, they attempted to encourage development of CT using covert methods. While other respondents thought it was useful to present and discuss models of CT, all respondents agreed that convincing students of the need and importance of increasing CT skills was a challenge.

The literature on CT provides a different view of how CT should be taught than the recommendations from instructors. These two vantage points do not necessarily yield contradictory advice for new CT learning programs. Instead, they seem to yield different kinds of recommendations. Researchers and instructional experts agree that practical exercises are the best way to teach CT and acknowledge the possibility that distance based methods may be more effective. They also agree that examples that are realistic, practical, and context-rich are effective. However, the literature has more to say about methods of training. While instructional experts report satisfaction with current CT theories (Paul & Elder, 2001) and the use of practical exercises as a useful method, the literature suggests that a host of other techniques may be more effective. These techniques are discussed further in Volume Three of this series.

The results of the literature review and instructor survey informed an effort to establish functional requirements for a distance-learning program of CT training, $(CT)^2$.

FUNCTIONAL REQUIREMENTS FOR WEB-BASED TRAINING OF CRITICAL THINKING

To lay the groundwork for designing an Internet-based CT training program, an Instructional Systems Design (ISD) analysis was performed. The first steps in ISD include specification of an initial estimate of the capabilities of proposed instruction, the scope of the instructional problem, the location of instruction, anticipated student load, alternative instructional strategies, support for maintaining the system, facilities requirements, evaluation assessment, quality improvement metrics, and funding requirements.

Specification of these issues was partially addressed by conducting interviews with members of the ILE team who were responsible for revising CGSOC curriculum and by observing lessons in CT given at the Tactical Commanders Development Course of the SCP at CGSC. A summary of the results of the ISD analysis on each of these topics is given below. The functional requirements are discussed in more detail in Fischer, et al., (2008b).

Estimate of Instructional Capability

Interview respondents suggested courseware is needed that (1) can be accessed by any officer anywhere in the world and (2) contains lessons not addressed by current training. The new CT training should be easily accessed on the Internet to provide maximal distribution to Army personnel. It should complement and support the Army's doctrine for leadership, e.g. FM 6-22 (DA, 2006) and currently provided Army educational experiences in CT. Finally, it should address deficits in officers' CT as evidenced in observed deficiencies and errors in human performance associated with common battle command tasks.

Scope of Instructional Problem

The instruction should focus on a set of critical thinking skills that are important and problematic to battle command and the Military Decision Making Process (MDMP). Each skill should be trained separately and independently from the rest to meet the practical needs of instructors and students.

Location(s) of Instruction

The bulk of instruction should be located on the Internet, accessible through an Army-provided URL. Some instruction may reside in links to other sites (e.g., references, related on-line courses).

Target Audience

The student target audience should be any officer currently enrolled in one of the Army's training and/or educational facilities.

Alternative Instructional Strategies, Methods, and Media

Alternative instructional strategies, methods, and media should be addressed if expected training effectiveness is found to be lacking during the formative evaluations. The instructional strategy should be designed to optimize student participation, student feedback, student pacing, and instructional sequence.

SMEs for Training Development

A number of resources are required to develop the training system including Army subject matter expert (SME) participation to oversee/validate content development. To evaluate

the system's effectiveness, comments from students and/or instructors who participate in pilot tests of the system should be obtained.

Evaluation and Assessment Measures

Evaluation and assessment measures should be based on development of a measurement paradigm, which should also give rise to a set of robust measures of CT. The experience of Army SMEs/instructors should be utilized for validation of the measures.

Quality Improvement Metrics

The measures cited above should be adapted to assess how the process of CT has improved among the officers taking the course. The assessment measures should be focused not global. They should be designed to assess the particular aspects of CT that have been aided or not aided by the training, rather than just CT as a whole.

Additional Requirements

The interviews with the ILE team members and classroom observations also yielded additional requirements for new distance-based training programs in CT. Both sets of data suggest that special consideration be given to the population of adult learners for which training would be developed. Interview respondents favored a particular model of curriculum for adult learners, the Experiential Learning Model (ELM) (Kolb, 1984) which has been adopted by CGSC and others. Hence, two additional requirements for new CT training are that (1) factors that affect adult learners should be considered in the system's design, and (2) the ELM should serve to guide new curriculum development. Factors that affect adult learning are discussed first, followed by a summary of ELM.

COMPUTERIZED TRAINING OF CRITICAL THINKING $(CT)^2$

Based on the functional requirements noted above, a prototype training system was designed and developed to increase the CT skills of Army officers. The training system, Computerized Training of Critical Thinking $(CT)^2$ delivers distance-based training via the Internet for two CTS.

The design of $(CT)^2$ was guided by the results of a series of studies, reported in this document and elsewhere (Fischer, et al., 2008a; Fischer, et al., 2008b). The studies led to the identification of a set of pedagogical principles that served as the philosophical basis of $(CT)^2$'s design. These 17 principles are bulleted below.

- *CT Skills Can Be Learned, Trained, and Transferred.*
- *Practice is Essential.*
- *Feedback is Essential.*
- *Assessment is Essential.*
- *Training Conditions Should Optimize Transfer.*
- *Part-Training Methods are Most Effective.*

- *Focus on Important and Problematic Cognitive Tasks.*
- *Focus on Common and Consequential Errors.*
- *Use Training Methods Appropriate for Adults (Army Officers).*
- *Use Concrete Experience to Start.*
- *Training Should be Scenario Based.*
- *Training is increasingly Complex and Difficult.*
- *Training is Distance-based.*
- *Multimedia is Essential.*
- *Interactivity is Essential.*
- *Scoring Increases Motivation.*
- *Use innovative Training Techniques.*

Course Objectives

The focus of $(CT)^2$ is to improve key skills that support critical thinking and thus help Army personnel process information more effectively and efficiently. CT involves a deliberate, systematic awareness of the process and products of one's own thinking. The training program focuses on targeting common – and potentially serious – errors that people make when they fail to apply appropriate critical thinking skills. These errors include overlooking important details, misinterpreting information, and making incorrect assumptions – all of which can lead to poor decision-making. The training program highlights awareness of these errors and teaches specific techniques that can help people overcome them. It presents the student with real-world situations and asks them to complete numerous thinking exercises that require the practice and application of CT skills in a variety of realistic settings.

The Target Student Population

$(CT)^2$ was designed for Army personnel in leadership positions, although all personnel could benefit from the training. In order to make the training as meaningful as possible, realistic Army messages and situations were employed; therefore, before beginning the training program, students should have some Army training and experience. They should be familiar with Army terminology, acronyms, and standard report formats. They should, for example, be able to understand standard Army messages such as task organization tables, operation orders, mission statements, and battlefield sketches. $(CT)^2$ assumes students already have some domain knowledge; it gives them practice in applying strategies to use that knowledge most effectively.

Overview of $(CT)^2$ Format

The course is presented on the Internet in a Web-based format. It is divided into three sections: an introduction to the general topic of CT, followed by two main modules each of which focuses on a particular CTS. The Introduction to CT highlights the importance of developing CT skills and briefly outlines the organization and methods used in the course. The first module focuses on the CTS of framing a message, and the second module focuses on distilling the main gist of messages.

Each module comprises a series of elements or lessons designed to help students develop specific techniques that will help them interpret and critically perform the CTS in question more effectively. Specifically, each element provides training that is designed to reduce one or more common errors associated with the CTS.

Module Format

Each module is self-contained and presents training pertinent to a particular critical thinking skill. Although it is strongly recommended that the students progress through the modules in a suggested sequence described in the training, the instructor can assign students to specific modules or to modules in a different sequence than is recommended.

Organization and Content of Modules

Each module begins with an introduction to the particular CTS targeted by the module. The introduction section of the module opens with a concrete scenario illustrating the importance of the skill and the errors that can result when the skill is not applied. It then goes on to provide a clear definition of the CTS, as well as key concepts and terms and a brief explanation of how this cognitive task relates to critical thinking. This is followed by concrete examples illustrating the key concepts. The introduction section concludes with an outline of the main objectives of the module and a plan for how the objectives will be trained. The next section of each module consists of two to five sub-modules called *Cognitive Elements*. Each element targets a common CT error associated with the CTS.

Element Format

Each of several elements within each module targets a specific CT error and focuses on techniques that one can use to develop awareness of where, when, how, and why CT skills should be applied. Each element contains the following sections:

1. An opening scenario that illustrates the importance and prevalence of the CT error covered in the element
2. Main purpose of the element
3. Specific lesson objectives
4. Instruction providing content information, rationale, and practical applications
5. Training examples
6. Practice exercises
7. Summary of main point of the lesson, practical considerations and applications
8. Exit tests

Assessment Format

The exit tests at the end of each element provide a reinforcement of the material and inform the student and the instructor about the extent to which the student achieved the element lesson objectives. They include a knowledge, knowledge application, and skill application test. All tests are designed using best practices test construction and are graded by the computer – that is, they do not require the instructor to do the grading.

Access to Course

Students are assigned a password from the course administrator. Only students who have a password are able to log on to the program.

Course Syllabus

Course Introduction The course introduction provides a brief overview of CT, explaining what it is and why it is important, and outlining how the course is organized.

Skill 1: Frame the Message The first module provides instruction on the CTS, *Frame the Message*. It is designed to promote the ability to identify the essential elements of a message, understand the relationships among them, and describe a high-fidelity representation of the message. It addresses common battle command problems such as difficulty in establishing clear and accurate understanding of a commander's intent statement and difficulty in conveying clear intent. The main learning objectives of this module are: (1) developing awareness of message structure in order to better interpret, evaluate, critique, and remember key information; and (2) recognizing potential biases in interpreting information.

Skill 2: Recognize Gist in Material The second module provides instruction in the CTS, *Recognize Gist in Material*. It is designed to promote the ability to sort through the details in a message (written, graphical, visual, auditory, and/or tabular) and extract the gist therein. It addresses common battle command problems such as filtering overly-detailed operation orders in order to write clear and concise mission statements that capture the gist of the original message, and reducing the amount of time that time-pressed units have to spend on accurately extracting the essence of a mission. The main learning objectives of this module are: representing the essential points of a message in a clear, concise manner; and recognizing how the process of distilling the main idea encourages deeper processing and can lead to increased ability to remember, evaluate, and use the information.

Recommended Sequence of Training It is strongly recommended that students progress through the training in sequence, beginning with the introduction, moving on to CTS 1, CTS 2, and so on. However, the course has been designed so that each CTS can function as a stand-alone module.

Instructor's Role The course is designed to function as a stand-alone program and can be completed with minimal instructor involvement; however, instructors can augment the material by facilitating discussions, providing additional real-world examples, and by providing additional activities to reinforce and/or supplement the material covered in the course.

Suggested Implementation The course can be used in a classroom setting, as supplemental exercises completed outside of class, or it can be used as a distance-learning course.

Estimated Time to Complete the Course Each element is designed to take approximately 1.5 to 2 hours to work through the content information and do the practice training exercises.

EVALUATION OF $(CT)^2$

An investigation was conducted to evaluate the effectiveness, usability, and student acceptance of $(CT)^2$. The central objective of the research was to determine whether the new CT training system effectively increases measurable indicators of CT compared to two other learning conditions. The research also assessed participating students' attitudes and subjective evaluations of $(CT)^2$ as indicators of acceptance and usability. The evaluation is described in greater detail in Fischer, et al., 2008b).

Method

Participants

Nineteen Soldiers (17 males and 2 females) from the 85th Reserves Training Division volunteered to participate in the research.

Materials

Participants were randomly assigned to one of three CT training conditions. They either received Web-based training in one CT module of $(CT)^2$, completed distance-based coursework modeled after an existing CT class offered at CGSC, or received no training beyond what they had already been given as Reserve Army officers. All participants were first asked to complete a demographic questionnaire that gathered information about their rank, job position, and gender. Different sets of instructional materials were also developed and delivered to participants depending on the condition to which they were assigned.

Results and Conclusions

The results of this investigation indicate that military students find $(CT)^2$ highly acceptable. Although the sample of participants who used $(CT)^2$ was small, it was uniformly positively rated. Despite the extensive time commitment the training program requires, users found it interesting and well worth their time. Participants thought the program offered training not available elsewhere in the Army. The self-paced feature of the program appears to be one of the reasons it received favorable reviews. Participants thought it was highly relevant and beneficial to their military and civilian work.

Although $(CT)^2$ was well regarded, it is clear from reviewers' recommendations that the usability of the program needs improvement. Specifically, the program needs to have a better capability to navigate to previous pages and more flexibility in the use of its audio components. Users also wanted the system to allow them to make errors which it currently does not.

$(CT)^2$ also appears to be generally effective at encouraging critical thinking, at least about messages Army personnel must evaluate. The research clearly showed that the WBT enhanced memory for messages, possibly because it encourages greater depth of processing. The finding that memory of messages is enhanced after participating in $(CT)^2$ is a strong indicator that those messages have been processed at a deeper level.

$(CT)^2$ also seems to inhibit the production of inferences that go well beyond what is explicitly given in the message. Participants who took the $(CT)^2$ training made far fewer unjustified inferences than participants assigned to the other two training conditions. Examinations of the responses reveals that $(CT)^2$ participants did make inferences; however, they justified them by pointing out explicit information given in the message that supported their inferences. Therefore, $(CT)^2$ appears to encourage discrimination of what is "known" or "given" from what might be added (i.e., inferred) by the perceiver. The ability to make this distinction is critical to avoiding many errors of reasoning. In these data, for example, participants who were inclined to make unjustified inferences expressed beliefs that were clearly erroneous. These results suggest that $(CT)^2$ encourages evidence-based reasoning.

In summary, the present research provided an initial evaluation of $(CT)^2$, documenting its acceptance by military users and its effectiveness at improving CT. Future research should focus on comparing the effectiveness of other CT training programs to $(CT)^2$ using alternative indicators of CT.

SUMMARY

This report presented an overview of a research program to develop and validate a web based training in critical thinking for Army officers. Volumes Two and Three of this series describe this research in more detail. Volume Two describes a model of critical thinking, results of a literature review that provided the theoretical basis for the model, and experiments to validate the model. Volume Three of this series describes the training that was developed (Fischer, et al., 2008b). An expanded version of $(CT)^2$ is documented in Fischer, et al., 2008).

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CRITICAL THINKING TRAINING FOR ARMY OFFICERS
VOLUME ONE: OVERVIEW OF THE RESEARCH PROGRAM

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